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Short communication

Bioefficacy of post-emergence herbicides in soybean

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In soybean, weeds are controled by cultural, mechanical and chemical methods either alone or in combination of more than one methods. Weed management through manual weeding or hoeing although effective in reducing weed competition but it is not free from several limitations such as non-availability of sufficient manpower during peak periods, high labour cost, time consuming and not feasible under heavy soils and high rainfall areas. Moreover, mechanical weeding disturbs the physical conditions of the soil and cause mechanical injury to roots and shoots. To overcome these problems, weed control in soybean by chemicals is preferred, which is effective, cheaper and many times faster than the conventional methods.

A field experiment was conducted during rainy season of 2009-10 at Research Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh). The soil of the experimental field was sandy clay loam in texture, neutral in reaction having 0.68 per cent organic carbon. The soil was low in available N (215 kg/ha), P (9.20 kg/ha) and medium in K (318.0 kg/ha). Nine treatments, *viz.* imazethapyr (75 g/ha), imazethapyr (100 g/ha) imazethapyr + adjuvant (75 g + 1 l/ha) imazethapyr + adjuvant + ammonium sulphate (100 g + 750 ml + 1 kg/ha), chlorimuron-ethyl (9.7 g/ha), fenoxoprop-ethyl (67.5 g/ha), weed free (HW at 30 DAS) and weedy check were tested in randomized block design with three replications. Healthy seeds (70 kg/ha) of soybean cv. '*JS 97.52*' were treated before sowing with thiram at the rate of 3 g/kg and sown in furrows opened manually at 30 cm apart rows. The soybean crop fertilized with 20 kg N (urea) : 60 kg P_2O_5 (single super phosphate) and 20 kg K_2O (muriate of potash) at the time of sowing. The total rainfall received during the period of experimentation was 1339.3 mm. The quadrate of 0.25 m^2 was used to count the weeds in each plot. The data were transformed and expressed in per square meter. The percentage of weed flora was estimated from weedy check. Weed control efficiency (WCE) was estimated by the formula given by Mani *et al.* (1973).

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The weed flora of the experimental field consisted of both grassy weeds, *viz. Cyperus rotundus, Digitaria sanguinallis* and *Eleusine Indica* and broad-leaved weeds, *viz. Portulaca oleracea* and *Eclipta alba*.

Density and relative density of monocot weeds were higher than the dicot weeds both at 40 and harvest growth stages (Table 1). In weedy check, total weed population was significantly higher than all the herbicidal treatments including weed free treatments. Among herbicidal treatments, imazethapyr + adjuvant + ammonium sulphate (100 g + 750 ml + 1 kg/ha) was most effective in reducing most of the weeds and was almost similar to hand weeding. But, if imazethapyr was applied without adjuvant and ammonium sulpate, its effect on weeds was not appreciable. Weedy check had the highest weed biomass and it had reduced significantly when weeds were controlled either by the use of herbicides or hand weeding. The lowest weed biomass was recorded under weed free treatment (Table 2), closely followed by imazethapyr + adjuvant + ammonium sulphate (100 g + 750 ml + 1 kg/ha). Application of imazethapyr at 75 and 100 g/ha with adjuvant found significant to reduced the weed biomass than the application of imazethapyr alone and other herbicides (Kushwah and Vyas 2009).

Table 1. Weed flora in control at 40 DAS and harvest

Weed species	Density (no./m^2)		Relative density (%)	
	40 DAS	Harvest	40 DAS	Harvest
Monocot weeds				
Grasees				
Digitaria sangunallis	8.2	8.8	18.6	18.2
Eleusine indica	10.2	11.2	24.6	24.8
Sedges				
Cyperus rotundus	11.1	10.9	25.2	24.1
Dicot weeds				
Partulaca oleracea	3.5	4.0	8.1	7.8
Eclipta alba	5.3	5.8	12.1	12.8
Other weeds	5.1	5.5		
Total	44.2	45.2		

Table 2. Species-wise dry weight of weeds at 40 DAS and harvest as influenced by different weed control treatments (g/m²)

Treatment	*Digitaria sanguinallis*		*Eleusine indica*		*Cyperus rotundus*		*Partulaca oleracea*		*Eclipta alba*		Others	
	40 DAS	Harvest	40 DAS	Harvest	40 DAS	Harvest	40 DAS	Harvest	40 DAS	Harvest	40 DAS	Harvest
Imazethapyr (75 g/ha)	4.75 (22.05)	3.72 (13.32)	4.17 (16.86)	3.73 (13.41)	2.79 (7.27)	2.00 (3.52)	3.32 (10.53)	2.57 (6.13)	2.51 (5.80)	1.64 (2.20)	2.02 (3.60)	1.39 (1.43)
Imazethapyr (100 g/ha)	4.34 (18.33)	3.35 (10.73)	3.73 (13.40)	3.27 (10.20)	2.76 (7.13)	1.89 (3.07)	3.02 (8.60)	2.44 (5.47)	2.39 (5.20)	1.62 (2.13)	1.99 (3.47)	1.31 (1.23)
Imazethapyr + adjuvant (75 + 1/ha)	4.18 (16.97)	2.98 (8.40)	3.47 (11.53)	2.63 (6.40)	2.63 (6.40)	1.68 (2.33)	2.75 (7.07)	2.17 (4.20)	2.27 (4.67)	1.46 (1.64)	1.65 (2.22)	1.18 (0.90)
Imazethapyr + adjuvant (100 g + 1/ha)	3.11 (9.16)	2.52 (5.87)	2.91 (7.97)	2.15 (4.13)	2.53 (5.93)	1.60 (2.07)	2.42 (5.36)	2.03 (3.64)	2.22 (4.43)	1.37 (1.37)	1.56 (1.94)	1.18 (0.90)
Imazethapyr + adjuvant + AS (100 g +750 ml + 1 kg/ha)	2.60 (6.27)	2.11 (3.94)	2.61 (6.33)	1.99 (3.47)	2.49 (5.70)	1.50 (1.77)	2.32 (4.87)	1.95 (3.29)	2.08 (3.82)	1.30 (1.20)	1.52 (1.82)	1.11 (0.73)
Chlorimuron-ethyl (9.7 g/ha)	5.42 (28.85)	4.36 (18.50)	4.89 (23.43)	4.42 (19.07)	3.23 (9.97)	2.17 (4.2)	3.69 (13.15)	2.68 (6.70)	2.43 (5.42)	1.68 (2.33)	2.04 (3.67)	1.70 (2.40)
Fenoxoprop-ethyl (67.5 g/ha)	4.87 (23.24)	3.85 (14.34)	4.41 (18.98)	3.41 (11.13)	2.93 (8.10)	1.93 (3.22)	4.00 (15.49)	2.92 (8.03)	2.53 (5.93)	1.75 (2.58)	1.95 (3.29)	1.53 (1.83)
Hand weeding once at 30 DAS	2.01 (3.53)	1.38 (1.40)	1.66 (2.27)	1.66 (2.26)	1.47 (1.67)	1.21 (0.97)	0.71 (0.00)	0.71 (0.00)	1.31 (1.21)	1.28 (1.13)	1.30 (1.20)	0.98 (0.47)
Weedy check	5.86 (33.80)	6.12 (37.00)	9.24 (84.86)	9.84 (96.33)	4.12 (16.50)	4.39 (18.80)	5.19 (26.4)	5.97 (35.20)	3.13 (9.33)	3.77 (13.75)	4.08 (16.15)	8.42 (70.49)
LSD (P=0.05)	0.55	0.38	0.60	0.49	0.45	0.30	0.47	0.87	0.39	0.55	0.25	0.40

Table 3. Weed control efficiency (WCE%) and weed index of different weed control treatments over weedy check

Treatment	WCE at 40 DAS	WCE at harvest (%)	Weed index
Imazethapyr (75 g/ha)	64.7	85.3	30.3
Imazethapyr (100 g/ha)	70.0	87.9	22.9
Imazethapyr + adjuvent (75 g/ha + 1 liter)	73.9	91.2	17.8
Imazethapyr + adjuvant (100 g/ha + 1 l/ha)	81.4	93.4	5.9
Imazethapyr + adjuvent + AS (100 g/ha + 750 ml/ha + 1 kg/ha)	84.6	94.7	3.1
Chlorimuron-ethyl (9.7 g/ha)	54.8	80.4	35.2
Fenoxoprop-ethyl (67.5 g/ha)	59.9	84.9	32.1
Hand weeding at 30 DAS	94.7	97.7	00.0
Weedy check	0.0	0.0	52.9

Weed-free treatment registered maximum weed control efficiency than all other treatments because of least dry matter production of the weeds over weedy checks (Table 3). The next best treatment was imazethapyr + adjuvant + ammonium sulphate (100 g + 750 ml + 1 kg/ha). These findings were in agreement with Shete *et al.* (2007).

All yield attributing characters, *viz.* branches/plant, leaf area index (LAI), dry matter productions were significantly different due to different treatments. Significantly maximum number of branches/plant (3.67), LAI (9.25), dry matter production (1.2 kg/m²) was recorded under weed free condition followed by imazethapyr + adjuvant + ammonium sulpate (100 g +750 ml + 1 kg/ha). This may be because of effective control of weeds which promoted the better growth and development of plants and ultimately produced higher yield attributing traits than the weedy check and other herbicidal treatments. These results are in confirmation with findings of Mishra *et al.* (2001) and Dhane *et al.* (2009).

Pods/plant and seed yield were significantly higher under weed free treatment closely followed by imazethapyr + adjuvant + ammonium sulphate (100 g +750 ml + 1 kg/ha). Excellent growth and development of soybean plants under weed free conditions and imazethapyr applied along with adjuvant and ammonium sulpate were noted. Because,

Table 4. Effect of herbicdes on yield and economics of soybean

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Gross monetary returns (x10^3 ₹/ha)	Total cost of cultivation (x10^3₹/ha)	Net monetary returns (x10^3₹/ha)	B:C ratio
Imazethapyr (75 g/ha)	1.96	4.78	41.1	16.9	24.5	2.43
Imazethapyr (100 g/ha)	2.19	5.29	48.1	17.2	31.2	2.79
Imazethapyr + adjuvant (75 g/ha + 1 l/ha)	2.24	5.64	49.2	17.3	32.2	2.85
Imazethapyr + adjuvant (100 g/ha + 1l/ha)	2.52	6.45	54.6	17.6	37.3	3.10
Imazethapyr + adjuvant + AS (100 g/ha +750 ml/ha + 1 kg/ha)	2.56	6.65	56.4	17.6	39.1	3.20
Chlorimuron-ethyl (9.7 g/ha)	1.64	4.45	36.3	16.1	20.6	2.27
Fenoxoprop-ethyl (67.5 g/ha)	1.81	4.65	39.5	17.1	22.9	2.33
Hand weeding at 30 DAS	2.65	6.86	58.5	18.7	39.9	3.14
Weedy check	1.25	3.23	27.6	15.6	11.9	-

both these treatments provided congenial environment at critical period of crop- weed competition than the weedy check, resulted in most inferior seed yield (1.3 t/ha). These results are in close conformity with the findings of Pandya *et al.* (2005).

The minimum gross monetary returns (₹ 25,577/ha), net monetary returns (₹11,937/ha) and B:C ratio (1:1) was recorded under weedy check treatments than the other treatments. The maximum gross returns (₹58,533/ha) and net monetary returns (₹39,893/ha) was observed under weed free conditions closely followed by imazethapyr (₹ 56,419 and 38,809/ha) + adjuvant + ammonium sulphate (100 g +750 ml + 1 kg/ha). The benefit : cost ratio represents the profitability of the treatments with each rupee investment. It is remarkable (Table 4) to note that the application of imazethapyr + adjuvant + ammonium sulphate (100 g + 750 ml + 1 kg/ha) was more remunerable (3.20) than rest of the treatments including weed free treatment (3.14). While weedy check was not advantageous as there was loss of almost 100 paise per rupee investment. Similar findings have also been reported by Bhan and Kewat (2003).

SUMMARY

A field experiment was conducted during rainy season of 2009-10 at Research Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur to study the bio-efficacy of post-emergence herbicides on weeds in soybean. Early post-emergence applications of imazethapyr with adjuvant and ammonium sulphate (100 g + 750 ml + 1 kg/ha) was most effective in paralyzing the weed growth and producing significantly higher yield attributing characters and seed yield (2.6 t/ha). The same treatment recorded the maximum net monetary returns (₹ 39,109/ha) and B:C ratio (3.20). The minimum seed yield (1.3 t/ha) was recorded under weedy check.

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